

## A Study on Blunt Thoracic Trauma with Medico Legal Significance

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**How to cite this article:** Gunathilaka M.M.A.C, Kitulwatte I.D.G, Handun Wijewardena et. al. A Study on Blunt Thoracic Trauma with Medico Legal Significance. Indian Journal of Forensic Medicine and Toxicology 2023;17(1).

### Abstract

**Introduction:** Thoracic trauma (TT) accounts for significant mortality and morbidity. Blunt thoracic trauma is reported more frequently than sharp force trauma, where motor traffic collisions account for the majority. Addressing medico-legal issues is often a challenge in TT. The purpose of this study was to evaluate blunt chest trauma from a medico-legal point of view.

**Methods:** A retrospective descriptive study was conducted based on case records of the victims (living and dead) of TT over three years presented to a Teaching Hospital and a District General Hospital in Western Province.

**Results:** There were 248 living patients and 195 deceased. Road accidents accounted for TT in 236 (53.3%), followed by 166 (37.5%) assaults. Out of the deceased, 89% had a very short survival period. "Multiple chest injuries" was the cause of death in 83 (42.5%) dead, and 91 (46.7%) died due to TT. Road accidents accounted for N=71 (78% of deaths due to TT). Out of the live patients, 87 (35.8%) had grievous or above-category injuries to the chest, and victims of assault were commonly having non-grievous injuries with a significant association ( $p < 0.001$ ). A total of 175 (39.5%) had rib fractures, and 125 were following motor traffic accidents.

**Conclusions:** Blunt TT accounts for significant mortality and morbidity, with the most common circumstances being road accidents. Most of them come under a severe category of hurt with a short survival period among the dead.

**Keywords:** Thoracic trauma, Blunt force, Medico-legal significance

### Introduction

Trauma accounts for many deaths, especially among the young, and it is the third leading cause of death (COD) in all age groups after cardiovascular

diseases and cancer<sup>[1]</sup>. Although trauma-related injuries can occur in many parts of the body, thoracic trauma makes a vital contribution to mortality and morbidity. One in four trauma patients reported succumb to thoracic trauma (TT) or its

complications<sup>[2]</sup>. It is a serious problem today due to many high-speed vehicle accidents. TT can be of two types, penetrating and blunt. Penetrating injuries such as stabs and firearm injuries destroy tissue integrity. Blunt injuries can cause damage to organs and structures without damaging the integrity of the tissue.

Blunt thoracic trauma is more common than penetrating chest injury, accounting for more than 90% of thoracic injuries. Blunt injuries to the chest are one of the leading causes of morbidity and mortality in both young and old trauma victims <sup>[3]</sup>. After the head, the chest is the next most common region of injury, and severe internal damage is often present in the absence of visible external injuries <sup>[4]</sup>. In vehicle occupant fatalities, injuries to the chest are even more common than head injuries <sup>[4]</sup>.

Blunt trauma to the chest can produce a spectrum of injuries ranging from no injury and minor injury to life-threatening or fatal injury. The walls of the chest and soft tissues are most commonly affected by blunt trauma <sup>[5]</sup>. Rib fractures are the most common blunt chest injury in adults and children <sup>[6]</sup>. Blunt injury to the chest can potentially pose a threat to the airway, breathing and circulation, thus directly affecting the clinical course and outcome of the victim <sup>[6]</sup>. Road traffic trauma, assault, and falls are common causes of blunt chest injuries. Out of these, 70% -80% of blunt chest injuries are due to traffic accidents <sup>[7]</sup>.

Studies have been conducted for the forensic assessment of blunt thoracic trauma in various populations <sup>[8] [9] [10]</sup>. There are limited studies in Sri

Lanka regarding thoracic trauma <sup>[11]</sup>. Furthermore, there are no studies on blunt chest injuries from a medico-legal point of view in Sri Lanka.

## Objectives

To study the medico-legal significance of blunt chest injuries among the victims of chest trauma presented to Colombo North Teaching Hospital and District General Hospital Gampaha for medico-legal examination and postmortem examination.

## Study design

A retrospective descriptive study was conducted based on case records of the victims of chest injuries for three years who had been presented with chest injuries for medico-legal examination and postmortem examination at Colombo North Teaching Hospital and District General Hospital Gampaha.

## Data Analysis:

Data were entered into Microsoft Excel worksheets and analysed using Statistical Package for Social Sciences (SPSS). Frequencies and percentages are used to present the data. A comparison of different circumstances of chest injuries was made, and the significance of associations was measured with a P value.

## Results

Among study sample (N=443), a majority (n=280, 63%) of the victims were between 21 and 50 years of age (Figure 1). There were 350 (79%) males and 93 females (21%).

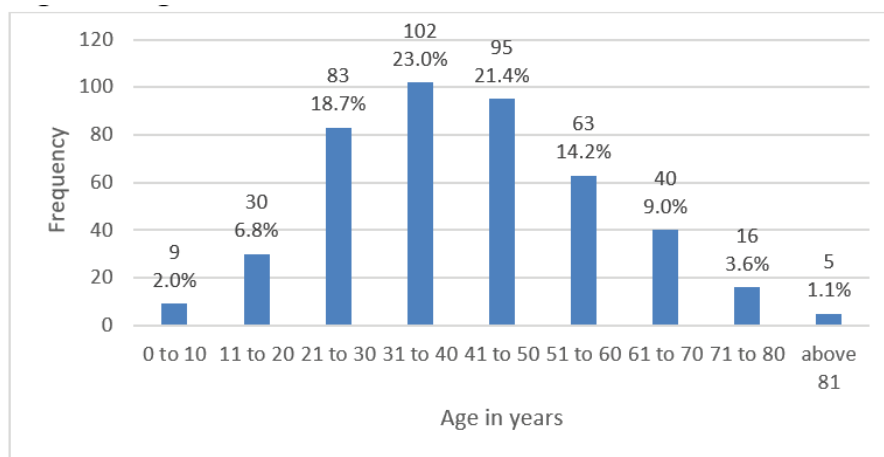


Figure 1: Age distribution of the victims

Most victims were brought following accidents. There were n=236 (53%) victims following road traffic accidents (RTA) and 166 (37.5%) victims of assault (Table 1). Among the victims of road accidents were 75 pedestrians, 16 pedal cyclists, 103 motorcyclists (rider or pillion rider), 17 three-wheeler drivers or passengers and 25 motor vehicle occupants. Among the other accidents, there were ten victims of railway track accidents and three domestic accidents.

There were 195 deaths and 248 live victims

among the group. Most deceased persons were victims of road accidents, while most live patients were admitted following assaults (Table 1). The chances of death are highest, with falls from height (91%) followed by accidents other than road accidents (80%). TT was responsible for n=91 (46.6%) of the total deaths among the victims of blunt chest trauma, which included multiple chest injuries (n=83), cardiac lacerations (n=5) and late complications (n=3) (Table 1).

**Table 1: Circumstances with COD and fate of victims**

		Assault	RTA	Simple fall	Fall from a height	Accidental (other than RTA)	Any other	Not known	Total
COD	Multiple injuries to chest	1 3.3%	68 51.5%	0	10 47.6%	4 50%	0	0	83 18.7%
	Cardiac laceration	2 6.7%	3 2.3%	0	0	0	0	0	5 1.1%
	Late complications	0	0	3 100%	0	0	0	0	3 0.6%
	Other than chest injuries	27 90%	61 46.2%	0	11 52.4%	4 50%	0	1 100%	104 23.5%
Fate of victims	Death	30 18.1%	132 56%	3 60%	21 91.3%	8 80%	0	1 100%	195 44%
	Injured	136 81.9%	104 44%	2 40%	2 8.7%	2 20%	2 100%	0	248 56%
	Total	166 37.5%	236 53.3%	5 1.1%	23 5.2%	10 2.3%	2 0.5%	1 0.2%	443 100%

Out of the deceased, 52.2% of the victims of road accidents who had a shorter period of survival or no period of survival had the cause of death recorded as chest injuries. In comparison, 6.7% of the deceased victims of assault who came under the same category had the cause of death as chest injuries (Table 2).

The category of hurt (COH) concerning TT was non-grievous among 201 (45%) victims (Table 3).

Out of the 166 victims of assault, 136 (82%) had non-grievous injuries to the chest. In contrast, out of the 236 road accident victims, 182 (77%) had injuries categorized as grievous or above in their chest, which included 16 victims with necessarily fatal (NF) injuries and 52 with injuries that are fatal in the ordinary course of nature (FIOC/N). There was a significant association in the categories of hurt according to the circumstances ( $X^2(1, N=443) = 273.72, p < 0.001$ ).

**Table 2: Circumstances vs Period of survival for the victims died due to TT**

	Assault	RTA	Simple fall	Fall from a height	Accidental (other than RTA)	Any other	Not known	Total
Death confirmed at scene	2 66.7%	32 45.1%	0	4 40%	4 100%	0	0	<b>42</b> <b>21.5%</b>
Dead on admission	0	16 22.5%	0	3 30%	0	0	0	<b>19</b> <b>9.7%</b>
Few hours	0	21 29.6%	0	0	0	0	0	<b>21</b> <b>10.8%</b>
1 - 2 days	1 33.3%	0	0	0	0	0	0	<b>1</b> <b>0.5%</b>
3 - 7 days	0	2 2.8%	0	0	0	0	0	<b>2</b> <b>1%</b>
>7 days	0	0	3 100%	3 30%	0	0	0	<b>6</b> <b>3.1%</b>
TT total	3 10%	71 53.8%	3 100%	10 47.6%	4 50%	0	0	<b>91</b> <b>46.7%</b>
Other than TT	27 90%	61 46.2%	0	11 52.4%	4 50%	0	1 100%	<b>104</b> <b>53.3%</b>
Total deceased	<b>30</b>	<b>132</b>	<b>3</b>	<b>21</b>	<b>8</b>	<b>0</b>	<b>1</b>	<b>195</b>

**Table 3: Category of hurt of TT vs cause of death**

COH	Multiple chest injuries	Cardiac laceration	Late complication	Other than chest injury	Not applicable (Live victims)	Total
Non grievous	0	0	0	40	161	201
Grievous (other)	1	0	0	36	75	112
Grievous (Endanger Life)	10	0	3	23	12	48
FIOCN	54	5	0	5	0	64
NF	18	0	0	0	0	18
Total	83	5	3	104	248	443

The most common form of bony injury was rib fractures. There were 175 (39.5%) individuals with rib fractures (Table 4). Among the victims of motor traffic accidents were 57 pedestrians and 37 motorcyclists with rib fractures. Among the road trauma victims, 76% of the pedestrians and 36% of the motorcyclists had rib fractures.

There were 63 clavicular fractures, and 52 resulted

from road accidents, i.e., 22% of all road accident victims (Table 4). Fractures of the vertebrae were the next most common bony injury (n=25), which was again common among road accidents (n=16) victims, followed by falls from heights. (n=7). (Table 4). However, the percentage of the victims of falls from a height with vertebral fractures was 30.4%, while it was only 6.7% for road trauma victims.

Among the victims, there were 110 cases of hemothorax, pneumothorax or hemopneumothorax (Table 4). Commonly observed traumatic pathology of the body cavities was hemothorax alone (n=76) or together with pneumothorax (n=18). Among them, n=69 (73%) were the result of road accidents, followed by 13 (13.8%) assaults. Among the victims of road accidents, motorcyclists (n=29) and pedestrians (n=23) were the most common.

Injuries to the lungs are frequently observed as internal organ trauma. There were 47 victims with lung contusions and 24 victims with lacerations of the lungs in our sample. Lung injuries were observed among 53 (22.4%) victims of road accidents and only 7 (4.2%) victims of assault (Table 4). Victims with lung

injuries included 48% of the total vehicle occupants and 37% of the injured pedestrians.

Frequently observed injuries to the heart were contusions (n=21) followed by lacerations (n=9). Most cardiac injuries were associated with road accidents (n=25), and many were on pedestrians (n=13). However, three-wheeler occupants were more susceptible than pedestrians since 29.4% of three-wheeler occupants were followed by 17.3% of pedestrians in the group.

There were 15 victims with damage to great vessels (aorta), and all of them were victims of road accidents (Table 4). Motorcyclists were high on the list, which included 11 victims with great vessel damage.

**Table 4: Circumstances vs bony and internal injuries**

	Assault	RTA	Simple fall	Fall from a height	Accidental (other than RTA)	Any other	Not known	Total
Rib fractures	27 16.3%	125 53%	3 60%	11 47.8%	9 90%	0	0	<b>175</b> <b>39.5%</b>
Sternal fractures	0	17 7.2%	0	3 13%	1 10%	0	0	<b>21</b> <b>4.7%</b>
Scapular fractures	1 0.6%	5 2.1%	0	0	0	0	0	<b>6</b> <b>1.3%</b>
Clavicle fracturs	5 3%	52 22%	2 40%	0	2 20%	2 100%	0	<b>63</b> <b>14.2%</b>
Vertebral fractures	0	16 6.8%	0	7 30.4%	2 20%	0	0	<b>25</b> <b>5.6%</b>
Lung injury	7 4.2%	53 22.4%	3 60%	2 8.7%	6 60%	0	0	<b>71</b> <b>16%</b>
Heart injury	2 1.2%	25 10.6%	0	0	3 30%	0	0	<b>30</b> <b>6.8%</b>
Great vessel (aorta) damage	0	15 6.3%	0	0	0	0	0	<b>15</b> <b>3.4%</b>
Hemothorax	13 7.8%	51 21.6%	3 60%	4 17.4%	5 50%	0	0	<b>76</b> <b>17.1%</b>
Pneumothorax	3 1.8%	9 3.8%	0	2 8.7%	2 20%	0	0	<b>16</b> <b>3.6%</b>
Haemopneuomothorax	0	18 7.6%	0	0	0	0	0	<b>18</b> <b>4.1%</b>
<b>Total</b>	<b>166</b>	<b>236</b>	<b>5</b>	<b>23</b>	<b>10</b>	<b>2</b>	<b>1</b>	<b>443</b>

## Discussion

**Thoracic trauma causes approximately 25% of traumatic deaths worldwide** [12]. **More than 65% of thoracic trauma results from blunt impacts** [13]. Forensic medical experts are expected to opine on many medico-legal issues on thoracic trauma. These include assessment of severity, period of survival and possible volitional activities, determination of the mechanism of causation and mechanism of death, identification of causative force/weapon, and determination of the circumstances.

The study revealed that a majority of TT is a result of accidental trauma, especially road accidents. Furthermore, most of them are vulnerable road users, including riders of motorcycles and pedestrians. Motor vehicle accidents cause over 70% of victims with blunt TT reported in previous studies worldwide [7] [13].

Most deceased persons were victims of road accidents, while most live patients were admitted following assaults. Chest injuries were responsible for 46.6% of deaths among the victims of blunt chest trauma, while 53.7% of the deceased victims of road trauma and only 10% of dead victims of assaults with TT succumbed to TT.

The chances of dying are highest with falls from height, followed by accidents other than road accidents, even though they are common among dead victims due to their high prevalence. Out of the total road trauma victims, 56% had died, and out of the victims of assault, only 18% had died. However, the cause of death among 90% of the victims of assault was injuries other than chest injuries, and they had a fatal injury to the head. According to a published study on blunt TT, none of the victims of assaults with TT had died [8].

Out of the deceased victims, 89% had a very short survival period. The majority among this group were road trauma victims, 94% of deceased victims due to road trauma, and 90% of dead victims of assaults were among them. Injuries other than chest injuries accounted for the on-the-spot deaths of 50% of victims of accidents other than road accidents. There was a significant association of fatalities on the spot with accidents other than road accidents.

All victims with injuries that are 'necessarily fatal' and the injuries that are 'fatal in the ordinary course of nature' involving the chest had died. Among the group who died from injuries other than chest injuries, 73% had either non-grievous or uncomplicated grievous injuries to the chest. TT is observed in approximately 60% of victims with polytrauma, with a mortality of 20-25% [14] [15]. Consistent with our finding, the literature has shown that a relatively higher number of minor injuries are reported with assaults. More serious injuries are reported in motor vehicle accidents [8].

Rib fractures are common injuries accounting for 60-80% of all victims with blunt TT [7]. The relatively low percentage of rib fractures among our sample could be due to having many victims following assaults in this group. Rib fractures included 27 victims of assaults, i.e. 16% of the total assault cases, even though rib fractures are described as non-accidental injuries in children and are not commonly identified as a complication of blunt impact assaults [8]. The study sample included only nine young children who were not victims of battered baby syndrome. There was no specific association of the location of rib fractures with the circumstances of the injury. Motor vehicle collisions cause anterolateral or postero-lateral rib fractures, while simple falls result in lateral fractures [16]. Most of these assaults and fights are associated with falls, which may be why they have no specific association.

Among the cases of clavicular fracture, a total of 43.75% of all pedal cyclists, followed by 25% of pedestrians, had clavicular fractures. Forces directly applied to the lateral shoulder are responsible for more than 80% of clavicular fractures [17], while some result from falls on the outstretched hand or direct blows to the area [18]. The direct forces applied are most commonly reported in falls on the shoulder following road accidents [19]. This was also evident in our study since falls following crashes are inevitable among pedal cyclists and pedestrians.

The percentage of victims of 'falls from a height' with vertebral fractures is almost five times greater than that for road trauma victims. The most common traumatic cause of vertebral fractures reported is high energy trauma, including falls from great heights and motor vehicular collisions [20].

Blunt chest trauma is the most common underlying reason for hemothorax and pneumothorax [21]. Such findings in the pleural space are expected with chest wall injuries, especially rib fractures [22]. Since 39.5% of individuals had rib fractures, this is expected.

Pulmonary contusions are reported most commonly among drivers of motor vehicles due to compression with the steering wheel [23]. This explains the involvement of a higher percentage of vehicle occupants compared to other victims of road accidents. High-speed motor vehicular crashes are responsible for lung lacerations [23].

Direct impact to the anterior chest, sudden high-speed deceleration, compression of the chest, or a combination of those could result in blunt cardiac trauma [24]. This is consistent with our finding as most cardiac injuries were associated with road accidents.

The most frequent location of the tear was the junction between the arch and the descending aorta (67%). In previous studies, approximately 80% of traumatic aortic ruptures have been reported at this site [25].

### Conclusions

Road accidents are responsible for the most severe medicolegally significant blunt thoracic injuries and deaths due to blunt thoracic injuries, while inter personnel violence is associated with less severe injuries. Rib fractures were observed frequently and were especially common among pedestrians following road trauma. There was a significant association of some of the internal injuries with different circumstances of causation, which can be used in event reconstruction.

**Ethical clearance:** Taken from Ethics Review Committee, Faculty of Medicine, University of Kelaniya, Ragama, Sri Lanka

**Source of funding:** Self

**Conflict of Interest:** Nil

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